Impact of Decortication on Chemical Composition, Antioxidant Content and Antioxidant Activity of Little Millet Landraces

Department of Food Science and Nutrition,
University of Agricultural Sciences Dharwad, Karnataka-580005

Nazneen G. Kundgol, Kasturiba B., K. K. Math., M. Y. Kamatar and Usha M.

Abstract: By any nutritional parameter, millets are miles ahead of rice and wheat. Millets are rich in protein, fibre and micronutrients. From the farmers of different Districts of Karnataka i.e., Dharwad, Haveri and Chitradurga 92samples of little millet landraces wereprocured which were grown in the year 2007-09.Chemical composition was recorded using NIR (near infrared radiation) and antioxidant activity was analysed using DPPH(2,2-diphenyl- 1-picrylhydrazyl).After milling there was reduction in α- tocopherol content. It is also observed that, bran contained higher amount of α- Tocopherol compared to decorticated grain. Bran contained highest polyphenol content because polyphenols are concentrated in bran. In whole grains, zinc, copper, manganese and iron contents ranged from 0.24 to 0.50 mg/100g, 0.24 to 0.58 mg/100g, 0.08 to 0.16 mg/100g and 1.28 to 3.05 mg/100g. The antioxidant activity in whole millet grain ranged from 19.06 to 24.33 per cent in millets collected from Chadaval-66 and Mantrodi -77. Antioxidant activity in decorticated grain varied from 12.80 to 23.52 per cent in millets collected from Chikkayagatti -07 millet and Jekinkatti-82 millet. Bran contained highest antioxidant activity compared to decorticated grain and whole millet grain.

Introduction:

Diet consisting of whole grains are known to slow the process of digestion and absorption of carbohydrates. Studies have shown that blood glucose and insulin responses are affected by physical structure of food. Diets based on whole grains slow down glyceamic response. Consumption of whole grain foods reduce the post pandrial blood glucose in diabetes and plasma insulin responses are reported to increase in step wise manner. Whole grains also contain many antioxidants, namely vitamins, trace elements, non-nutrients such as phenolic acids, lignans and phytoestrogens which are rich sources of selenium. The outer portion of grains is rich in phenolic acids and trace minerals such as copper, zinc and manganese. Phytic acid present in grains chelates with various metals suppressing chemical reactions. Vitamin-E another antioxidant present in whole grains becomes unavailable in refining process. In our country where cereals are main source of energy and the food basket contains many cereals and millets specific to particular region, they are superior in protective nutrients and produces protective health effects.

Several studies have been conducted on the antioxidant properties of grains such as Little millet.

Little millet (*Panicumsumatrense*) is one of the important minor millet grown extensively in the tropics and a staple food for the low income groups in some countries of the world. Little millet is comparable with other cereals, such as rice and wheat as a source of protein, fat, carbohydrates and crude fibre, apart from minerals and vitamins. Millets are also rich source of antioxidants. Now a days the role of antioxidants in human health is gaining more importance. Free radicals are produced in human body constantly and are capable of attacking the healthy cells of the body, causing them to lose their structure and functions.

Cell damage caused by free radicals appears to be a major contributor to ageing and to degenerative diseases of aging such as cancer, cardiovascular disease, cataract, immune system decline, and brain dysfunction. This free radical formation is controlled naturally by beneficial compounds known as antioxidants.

"Anti" is defined as against, in opposition to, or corrective in nature. An "antioxidant" helps to correct oxidation of the cells by binding with the harmful free radical molecules and terminating the chain reactions, flushing other free radicals out of body, repairing damage already done, and stopping other oxidation reactions by being oxidized themselves.

Natural antioxidants have gained considerable interest in recent years for their role in preventing auto oxidation of fats and oils. Both synthetic and naturally occurring substances may possess health-promoting potential. Since the public call for an ‘additive free’ and ‘natural’ diet, major interest has been devoted to substances naturally occurring in the diet (Verhagen1993; Caragay1992). Grains contribute to the significant supply of antioxidant to prevent oxidative stress due to the fact that grains are used as a staple food and are consumed in larger amount in our diets (Choi et al. 2007). Recent epidemiological studies have suggested that increased consumption of whole grains, ruits and vegetables is associated with reduced risks of chronic diseases (Hu 2002). This may be attributed to the presence of natural antioxidants from plant foods such as vitamin C, tocopherol, carotenoids and polyphenols which prevent free radical damage (Diplock et al. 1998). Millets are known to contain phenolic acids, which are located in the pericarp, testa, aleurone layer and endosperm (Hahn et al. 1984). Millets are rich in phenolicsacids, tannins and phytate which act as ‘antinutrients’ (Thompson 1993). However, it is now established that these antinutrients are known to reduce the risk for colon

and breast cancer in animals (Graf and Eaton 1990). However, millets have beenthe subject of less interest in any research.

2.1.Materials and methods:

Totally 92 little millet landraces were procured from the farmers of different Districts of Karnataka *i.e.*, Dharwad, Haveri and Chitradurga, grown in the year 2007-09. All the samples were collected at one lot, cleaned and stored in polythene covers and used for entire study. Based on chemical composition top 10 landraces were selected for further study.Antioxidant activity was estimated by procedure given by Brand-Williams, Cuvelier, and Berset (1995) using DPPH.

2.2.Sample preparation:

The seeds of little millets were cleaned manually to remove broken seeds, dust and other extraneous materials. Millets selected for the study were processed primarily by milling mainly to know the effect of processing on chemical composition, antioxidant content and activity in millets. Dehulling was done and hulls were separated by winnowing technique.

2.3.Proximate composition of the millet grains

The moisture content of the whole and milled grain was determined by oven drying at 100-105^{0}C for 5-6 hours. Protein content was determined by Kjeldhal method using Pelican kelplus,while fat was extracted with petroleum ether using soxplus apparatus. Ash content was determined by dry ashing using a muffle furnace at 550^{0}C and Crude fibre was estimated from the moisture and fat free sample. The residue obtained after digestion with acid and alkali was dried in crucible and weighed. The difference in weight of the crucible before and after ashing of the digested residues was taken as weight of the crude fibre. (Anon., 1990).

2.4. Estimation of α-tocopherol:

Pipetted out 1.5 ml of tissue extract,1.5 ml of standard and 1.5 ml of water into three centrifuge tubes and cap the tubes. To the test sample and blank, 1.5 ml of ethanol and to the standard 1.5 ml of water was added and centrifuged, 1.5 ml of xylene was added to all the three tubes, and centrifuged. To each tube 1.5 ml of 2,2'-dipyridyl reagent was added, stoppered and absorbance was recorded at 460 nm. Further 0.33ml of ferric chloride solution was added to blank,test sample and standard mixed well, after exactly 15 minutes at 520 nm absorbance was recorded.

2.5. Estimation of total phenols:

Phenols were estimated by the Folin-Ciocalteau method (Malick and Singh, 1980). Weighed exactly 0.5 mg of the sample and ground with a pestle and mortar in 10 time volume of 80% ethanol. Centrifuged the homogenate at 10,000 rpm for 20min.Re-extracted the residue with five times the volume of 80% ethanol, centrifuged and pooled the supernatants. Evaporated the supernatant to dryness.Dissolved the residue in a known volume of distilled water (5ml).Pipetted out different aliquots (0.2-2 ml) into test tubes. Make up the volume in each tube to 3ml with water. Folin-Ciocalteau reagent about 0.5 ml was added. After 3 min, 2 ml of 20% Na2CO3 solution was added to each tube, mixed thoroughly and kept the tubes in a boiling water for exactly one minute.Further cooled and measured the absorbance at 650 nm against a reagent blank.

2.6. Estimation of phytic acid content :

Phytic acid content was estimated by the method as described by Wheeler and Ferral (1971).A Weighed quantity of finely ground sample was extracted in 50 ml 3%TCA for 30 min with mechanical shaking. Centrifuged the suspension and transferred a 10 ml aliquot of the supernatant to a 40 ml conical centrifuge tube. Added 4 ml of FeCl3 solution to the aliquot by blowing rapidly from the pipette. Heated the contents in a boiling water-bath for 45 min. Centrifuged 10-15 minute, carefully decanted the clear supernatant and washed the precipitate twice by dispersing well in 25 ml 3% TCA.Further heated in boiling water for 5-10 minute and centrifuged. Repeatedly washed with water and added 3 ml 1.5 N NaOH with constant stirring.

Further it is filtered hot through a moderately retentive paper Whattman No.2. Washed the precipitate with 60-70 ml hot water and discarded the filtrate. The precipitate was dissolved from the paper in 40 ml hot 3.2 N HNO3 into a 100 ml volumetric flask. Paper was washed with several times in water, collecting the washings in the same flask. Transferred a 5 ml aliquot to another 100 ml volumetric flask and diluted to approximately 70 ml. Twenty ml of 1.5 M KSCN was added and diluted to 100 ml and colour was recorded immediately at 480 nm.

2.7. Estimation of trace minerals:

About 3g of dry sample was added to 25 ml 3:2:1 nitric acid, perchloric acid, sulphuric acid mixture and mixed well and left it for 4 hr. Heated for about 30 min until the initial vigorous reaction has subsided(dense yellow fumes will evolve).It was heated more strongly for 4 hr until most of the

nitrous fumes are removed and white fumes of perchloric acid evolve. The tubes are centrifuged for 30 min. Read the absorbance by atomic absorption spectrophotometer.

2.8. Antioxidant activity was evaluated in selected little millet landraces was measured using a modified version of the method explained by Brand-Williams, Cuvelier, and Berset (1995). This involved the use of free radical 2,2-diphenyl- 1-picrylhydrazyl (DPPH) solution in the methanol. Ground millet samples (1 g) were extracted with 10 ml methanol for 2 h and centrifuged at 3000g for 10 min. The supernatant (100 µl) was reacted with 3.9 ml of a of DPPH solution. Absorbance (A) at 515 nm was read at 0 and 30 min using a methanol blank. Antioxidant activity was calculated as % discoloration.

% Antioxidant activity = (1-(A of sample $_{t=30}$/A of control $_{t=0}$) x 100

2.9.Statistical Analysis

All analysis were carried out in triplicate and the data were reported as means ± SD.Mean values of data were analysed using spss version 16.0.Chemical analysis, antioxidant content and antioxidant activity was statistically analyzed. ANOVA was used to test the significant differences in whole grain millet, decorticated grain and bran for chemical composition, antioxidant content and antioxidant activity.

3.Results and discussion

3.1. Chemical composition of selected millets for study

There was a wide variation in chemical composition of little millet landraces collected from different localities specifically with regard to moisture, fat and ash, which was statistically significant. Protein and fibre did not vary significantly among landraces obtained from different locality. The highest moisture content was found millets collected from in S.S, Koppa (5.73%) followed by Chikkayyagtti (5.59%) and least was observed in Karikoppa (4.37%) .Fat content was highest in millets collected from Jekinkatti (4.78%) followed by Chadaval (4.62%) and least was observed in Shishunal (2.93%).Ash content in whole grain was highest in millets obtained from Shishunal (4.87%) followed by Tirumallakoppa (4.67%) and least was observed in Jekinkatti (1.52%). Similarly Sanaa*et al.*, in 2005 analyzed 4 cereals including barley, pearl millet, rye and sorghum, are adapted to the growing conditions of UAE. Barley whole grain had highest protein content (19.4%) and pearl millet exhibited the lowest levels (8.8%). Barley whole grain had the highest total ash content (2.9%) among

cereals, followed by rye, millet and sorghum(1.96%,1.82% and 1.87%). The nutritional status of soil might influence the nutritive value of crops.

3.2. Alpha tocopherol

Bran had the highest α-tocopherol content compared to decorticated grain and whole millet (Table). The values for α-tocopherol ranges between 1.75 and 5.44 mg/100g in whole grain millets. The highest was observed in millets collected from Mantrodi -77 (5.44 mg/100g) and lowest was in Chadaval – 53 (1.75 mg/100g) millet sample. Lower values were observed in decorticated grain, which ranges between 0.83 and 1.60 mg/100g.The highest value was noticed in millets obtained from Chikkayagatti-07 (1.60 mg/100g) and least was noticed in Kamplikoppa- 60 (0.83 mg/100g). The Percent retention of α-tocopherol varied among the millets. It ranged between 17.07 and 62.85 per cent .The highest retention was observed in millets collected from Chadaval - 53 (62.85%) followed by Jekinkatti- 82 (60.95%) and least was found in Kamplikoppa- 60 (17.07 %) sample. The values for α-tocopherol were high in blackish brown colour millets (4.26 mg/100g) compared to creamish millets. Youngmin et al.,2006 reported that black decorticated grain contain higher amount of vitamin E (1.2 mg/100g),where asproso millet contain least or negligible amounts of vitamin E (0.01 mg/100g).Alpha Tocopherol was high in landraces obtained from Haveri and Dharwad district. They were from collected Mantrodi and Ganjigatti respectively.

3.3.Phytic acid

Phytic acid is widely found in cereal, legumes, nuts and oil seeds constituting 1 to 5 percent. Decortication reduced the phytic acid content in decorticated grain. Phytic acid content did not vary significantly among the landraces and also when classified based on locality, colour and size. Sridevi and Yenagi (2007) conducted a study to evaluate antioxidant properties of locally available regional whole grain cereals such as bread wheat, durum wheat, dicoccum wheat, common sorghum, pop sorghum, *kadabinajola*, brown finger millet, white finger millet, pearl millet, foxtail millet and little millet and their processed foods (milled fractions, cooked and enriched foods). The highest phytic acid content was observed in brown ragi and lowest in little millet.

3.4.Phenols

Polyphenol did not vary significantly in the whole grains but decortication reduced the content of polyphenol in decorticated grain and variation was statistically significant. The landraces obtained from Dharwad region (Ganjigatti) was having highest content 145.90 mg/100g, compared to other two

localities, but colour and size did not show any significant influence. Anoma and Fereidoon in 2011 analyzed seven millet grain samples for total phenolic contents. Kodo millet showed highest total phenolic content in free (16.2±0.5 µ mole FAE /g), esterified (2.02±0.1 µ mol FAE /g) and insoluble bound fractions (81.6±0.2µ mol FAE /g) where as pearl millet contain highest total phenolic content in esterified fractions and also Youngmin et al., 2006 reported that Polyphenol content was more in red coloured sorghum (783 mg/100g), followed by black coloured decorticated grain (313 mg/100g) and least in white coloured decorticated grain (18mg/100g).

3.5.Trace minerals

Results revealed that zinc, copper, manganese and iron contents ranged from 0.24 to 0.50 mg/100g, 0.24 to 0.58 mg/100g, 0.08 to 0.16 mg/100g and 1.28 to 3.05 mg/100g in the millet samples. Among the millets,which collected from Jekinkatti -33 millet had highest zinc content (0.50 mg/100g) where asChadaval - 35 millet and Chadaval -53 millet had lowest (0.24 mg/100g) zinc content. Millets obtained from Chadaval- 53 had highest copper content(0.58 mg/100g) where as lowest was observed in Chikkayagatti - 01 (0.24 mg/100g).Manganese content was highest in millet collected from Chadaval -53 millet and Mantrodi -77 (0.16 mg/100g) while lowest was observed in Chikkayagatti - 01 and Kamplikoppa - 60 (0.08 mg/100g). Iron content was highest in millets obtained from Jekinkatti -33 (3.05 mg/100g) and lowest was in Mantrodi -77 (1.28 mg/100g) (Table 31, 33,35 and 37). Sanaa*et al*., 2005 evaluated barley, pearl millet, rye and sorghum (which are adapted to the growing conditions of United Arab Emirates) for minerals and total phenols. Barley had the highest levels of phosphorous, calcium, potassium, magnesium, sodium, copper and zinc and it was the second highest in iron content (128.4mg/kg) after millet. Rye appears to be rich in iron (43.0 mg/kg) and manganese (24.4 mg /kg) while millet had the highest content of iron content (199.8 mg/kg).

The percent retention of zinc content was highest in millets collected from Chikkayagatti -07 (138.70%) followed by Chadaval - 53 (124.90%) and least was observed in Jekinkatti – 82 (80.95%) samples. The copper retention was highest in millets collected from Chadaval -53 (165.7 %) followed by Kamplikoppa- 60 (139.9 %) and least was observed in Chadaval- 66 (52.94%) samples. The highest manganese retention was observed in millets obtained from Chikkayagatti – 01 (37.5%), Jekinkatti -33 (37.5%) and Kamplikoppa - 60 (37.5%) followed by Chadaval- 66 (36.36%) and least was found in Ganjigatti - 55 (30%) sample. The highest iron retention was observed in millets collected from Mantrodi -77 (115.6%) followed by Jenkinkatti- 82 (83.78%) where as least was observed in Chadaval - 35 (28.17%) sample.

Zinc, copper, manganese and iron vary significantly among the little millet landraces. Landraces obtained from Haveri region had slightly higher values of zinc compared to other two regions. The landraces which had creamish brown coloured grains have higher values compared to creamish and blackish brown coloured millets. Copper content was high in the landraces obtained from Chitradurga region compared to Dharwad and Haveri localities. It may be due to copper content of soil.

3.6. Antioxidant activity

All the methnol extracts from decorticated grain, bran and whole millet grain exhibited antioxidant activity. Preliminary processing like dehulling and decortications remove the outer layer of the grain but the nuetraceutical components are concentrated in outer layer only hence removal of bran drastically reduces the antioxidant activity. Bran contains highest antioxidant activity compared to decorticated grain and whole millet grains among all little millet samples selected for the study . The values ranged from 19.06 to 24.33 per cent. The highest values observed in millets collected from Mantrodi -77 (24.33%) followed by Kamplikoppa -60 (23.75%) and least was found in Chadaval -66 (19.06%). Based on colour when landraces were classified, the antioxidant activity was higher in blackish brown millets (23.63%) followed by creamish brown millets (22.30%) and least was observed in creamish millets (20.74%). Based on size the values ranged from 20.65 to 22.28 per cent. It was high in small size round millets (22.28 %) compared to big size round millets (20.74%). Sripriya*et al*., 1996 reported that DPPH radical quenching with 50 µl of the extracts showed that the brown finger millet quenched 94 per cent whereas the white finger millet quenched only 4 per cent because the total phenol content of brown finger millet was higher by 96% than the white variety, in the same way Asna and Suma (2010) reported that high antioxidant activity was observed in the extracts from bran rich fraction compared to whole flour, suggesting the presence of antioxidant components in the bran rich layer.

CONCLUSION:

Therefore, from the present study it can be concluded that little millet is a potential grain among the millets with superior nutrient and nutraceutical components.The concentration of bioactive constituents was greater in the outer layers of the grain; thus the bran fraction alone demonstrated a higher antioxidant activity than other milling fractions. Processing of cereals may thus have a significant effect on their antioxidant activity. The concentration of grain antioxidants will be drastically reduced during the refining process. As phenolic compounds are found to be concentrated in the outermost layers, the bran fractions obtained as milling by-products may be used as a natural source of antioxidants and as a value-added product in the preparation of functional food ingredients and/or for enrichment of certain products.

Table 1. Chemical composition (%) of Little millet landraces selected for the study

Sl. No.	Millets	Moisture	Ash	Fat	Protein	Fibre
1	Chikkayagti -01	5.50	4.67	3.04	7.68	2.71
2	Chikkayagti -07	5.59	4.63	4.26	7.49	2.61
3	Jekinkatti -33	3.95	3.00	4.53	7.65	2.66
4	Chadaval -35	5.63	2.80	3.18	7.51	2.79
5	Chadaval - 53	5.78	1.89	3.15	7.67	2.75
6	Ganjigatti -55	5.29	3.38	4.58	7.49	2.74
7	Kamplikoppa -60	5.74	4.78	4.49	7.68	2.74
8	Chadaval -66	5.73	3.17	4.71	7.43	2.81
9	Mantrodi- 77	3.46	4.71	4.37	7.58	2.71
10	Jekinkatti -82	5.75	4.70	4.48	7.45	2.61

Table 2. α- Tocopherol (mg/100g) content of milled fractions of little millet landraces

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagti -01	2.42	1.47	4.42	60
Chikkayagti -07	3.66	1.60	4.80	43.71
Jekinkatti -33	2.48	1.21	3.62	48.79
Chadaval -35	4.26	0.87	2.62	20.42
Chadaval - 53	1.75	1.10	3.31	62.85
Ganjigatti -55	4.90	1.18	3.54	24.08
Kamplikoppa -60	4.86	0.83	2.49	17.07
Chadaval -66	3.80	1.10	3.30	28.94
Mantrodi- 77	5.44	1.10	3.30	20.22
Jekinkatti -82	2.51	1.53	4.58	60.95
Mean	3.61	0.12	3.60	
SEM±	0.10	0.13	0.13	
CD	0.30*	0.38*	0.38*	

Note: Values are mean of three replications, SEm±-standard error of mean,

CD-Critical difference. Significant @ 5%,

Table 3.Phytic acid (mg/100g) content of milled fractions of little millet landraces

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	2.67	1.44	2.78	53.93
Chikkayagatti -07	2.69	1.48	2.60	55.93
Jekinkatti -33	2.72	1.47	2.82	54.04
Chadaval -35	2.73	1.47	2.75	53.84
Chadaval – 53	2.68	1.46	2.74	54.47
Ganjigatti -55	2.65	1.53	2.73	57.73
Kamplikoppa -60	2.78	1.51	2.72	54.31
Chadaval -66	2.47	1.48	2.81	59.91
Mantrodi- 77	2.65	1.52	2.73	57.35
Jekinkatti -82	2.70	1.53	2.74	56.66
Mean	2.68	1.49	2.74	
SEM±	0.09	0.04	0.06	
CD	NS	NS	NS	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference, NS-not significant

Table 4.Polyphenol (mg/100g) content of milled fractions of little millet landraces

Sl. No	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	136.53	67.90	235.40	49.73
Chikkayagatti -07	113.87	54.07	133.66	47.48
Jekinkatti -33	115.55	90.73	182.70	78.52
Chadaval -35	138.11	59.93	336.10	43.39
Chadaval – 53	130.08	49.47	184.96	38.03
Ganjigatti -55	145.90	61.51	190.76	42.15
Kamplikoppa -60	133.03	55.67	176.34	41.84
Chadaval -66	144.74	58.52	187.30	40.43
Mantrodi- 77	145.35	58.89	248.00	40.51
Jekinkatti -82	136.91	69.87	194.35	51.03
Mean	134.01	62.66	206.95	
SEM±	8.47	0.34	1.49	
CD	NS	1.00*	4.41*	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference, Significant @ 5 %,NS-not significant

Table 5. Zinc content of content of milled fractions of little millet landraces (mg/100g)

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	0.26	0.27	0.19	103.84
Chikkayagatti -07	0.31	0.43	0.36	138.70
Jekinkatti -33	0.50	0.32	0.60	120
Chadaval -35	0.24	0.29	0.27	120.8
Chadaval - 53	0.24	0.30	0.23	124.90
Ganjigatti -55	0.30	0.34	0.41	113.33
Kamplikoppa -60	0.38	0.36	0.27	94.73
Chadaval -66	0.29	0.29	0.14	99.99
Mantrodi- 77	0.27	0.27	0.30	99.99
Jekinkatti -82	0.42	0.34	0.34	80.95
Mean	0.32	0.32	0.31	
SEM±	0.06	0.05	0.15	
CD	NS	NS	NS	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference. NS-not significant

Table 6. Copper content of milled fractions of little millet landraces (mg/100g)

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	0.44	0.24	0.38	54.54
Chikkayagatti -07	0.54	0.39	0.47	72.22
Jekinkatti -33	0.50	0.44	0.40	88.00
Chadaval -35	0.35	0.39	0.40	111.42
Chadaval - 53	0.35	0.58	0.57	165.7
Ganjigatti -55	0.47	0.51	0.43	108.51
Kamplikoppa -60	0.30	0.42	0.48	139.9
Chadaval -66	0.51	0.27	0.39	52.94
Mantrodi- 77	0.38	0.35	0.45	92.10
Jekinkatti -82	0.42	0.42	0.50	99.99
Mean	0.43	0.40	0.45	
SEM±	0.09	0.08	0.10	
CD	NS	NS	NS	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference. NS-not significant

Table 7. Manganese content of milled fractions of little millet landraces (mg/100g)

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	0.08	0.03	0.25	37.50
Chikkayagatti -07	0.16	0.05	0.49	31.25
Jekinkatti -33	0.08	0.03	0.24	37.50
Chadaval -35	0.12	0.04	0.35	33.33
Chadaval - 53	0.16	0.05	0.47	31.25
Ganjigatti -55	0.10	0.03	0.29	30.00
Kamplikoppa -60	0.08	0.03	0.23	37.5
Chadaval -66	0.11	0.04	0.32	36.36
Mantrodi- 77	0.16	0.05	0.47	31.25
Jekinkatti -82	0.15	0.05	0.44	33.33
Mean	0.01	0.00	0.36	
SEM±	0.14	0.04	0.08	
CD	NS	NS	NS	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference. NS-not significant

Table.8. Iron content of little millet landraces at various stages of processing (mg/100g)

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	2.28	1.02	2.58	44.73
Chikkayagatti -07	2.85	2.21	3.45	77.54
Jekinkatti -33	3.05	1.06	2.97	34.75
Chadaval -35	2.91	0.82	2.52	28.17
Chadaval – 53	2.19	1.62	4.01	73.97
Ganjigatti -55	2.04	0.70	3.14	34.31
Kamplikoppa -60	2.34	1.06	3.34	45.29
Chadaval -66	1.61	0.97	3.78	60.24
Mantrodi- 77	1.28	1.48	3.63	115.6
Jekinkatti -82	1.48	1.24	3.28	83.78
Mean	2.20	1.22	3.27	
SEM±	0.60	0.50	0.82	
CD	NS	NS	NS	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference. NS-not significant

Table 9. Effect of processing on antioxidant activity of little millet landraces (% antioxidant activity)

Millets	Whole grain	Decorticated grain	Bran	% retention in decorticated grain
Chikkayagatti -01	21.56	14.89	33.89	69.06
Chikkayagatti -07	20.65	12.80	27.85	61.98
Jekinkatti -33	23.10	12.83	27.93	55.54
Chadaval -35	23.63	19.56	29.70	82.77
Chadaval – 53	19.74	17.94	30.30	90.88
Ganjigatti -55	21.74	17.02	31.34	78.28
Kamplikoppa -60	23.75	20.62	28.03	86.82
Chadaval -66	19.06	19.82	29.89	103.98
Mantrodi- 77	24.33	21.61	30.09	88.82
Jekinkatti -82	23.66	23.52	30.59	99.40
Mean	22.12	18.06	29.96	
SEM±	0.19	0.34	2.50	
CD	0.56*	0.99*	NS	

Note: Values are mean of three replications, SEm±-standard error of mean,
CD-Critical difference, NS-not significant, significant @ 5%

References:

Anoma, C., and Fereidoon, S. 2011.Determination of antioxidant activity in free and hydrolyzed fractions of millet grains and characterization of their phenolic profiles by HPLC-DAD-ESI-MSn.Functional Foods.3 :144 –158.

Anonymous, 1990, Official Methods of Analysisof the "Association of Official Analytical Chemists", 20th Edn.AOAC, Washington, D.C.

Asna, U., and Suma, P.F. 2010. Antioxidant activity of extracts from foxtail millet. Food Sci Technol. 11 : 300-309.

Brand, W.W.,Cuvelier, M. E., and Berset, C. 1995.Use of a free radical method to evaluate antioxidant activity.LebensmittelWissenschaft and Technologie, 28 : 245–251.

Malick, C.P., and Singh, M.B. 1980.In : Plant Enzymology and Histo Enzymology,Kalyani Publishers, New Delhi.p.286.

Sanaa, R., El-sayed, M., Abdel-Aal, and Maher. 2005. Antioxidant activity and nutrient composition of selected cereals for food use. Food Chem. 98 : 32-38.

Sridevi, and Yenagi, N.2007.Evaluation of antioxidant properties of grains and processed regional cereals of Karnataka.Ka.J. Agric. Sci. 21(4) : 602-603.

Sripriya, G., Chandrasekharan, K., Murty, V.S., and Chandra, T.S. 1996.ESR spectroscopic studies on free radical quenching action of finger millet *(Eleusinecoracana).*Food Chemistry.57(4): 537-540.

Wheeler, E.L., and Ferral, R.E. 1971.A method for phytic acid determination in wheat and wheat fractions.Cereal Chem.48: 312-320.

Youngmin, C., Heon-Sand J., and Lee, J. 2006. Antioxidant activity of methanolic extracts from some grains consumed in Korea. Agric and Food Chem.50 : 6182-6187.

Acknowledgement:

I express my heart full thanks to NAIP Project for providing me chemicals for my research work. I am fortunate enough to have the privilege and honour of working under the guidance of Dr. (Mrs.) RAMA.K.NAIK Former Dean.My heart is joyous to express its feeling with thanks to my parents,sisters,brother and sayedazharuddin for their co-operation.